Executive
Summary

The Berkeley Material Recovery/ Waste Conversion Facility

submitted to
City of Berkeley, California
Department of Public Works

submitted by
PB-Vicon Recovery Systems
A Joint Venture of Parsons Brinckerhoff
Development Corporation and
Vicon Recovery Systems, Inc.

October 15, 1982

City of Berkeley

COUNCILMEMBER FELLER

CITY MANAGER'S OFFICE
2180 MILVIA STREET
BERKELEY, CALIFORNIA 94704

October 21, 1982

To: Honorable Mayor and
Members of the City Council

From: DANIEL BOGGAN, JR., City Manager

Subject: SOLID WASTE MANAGEMENT PROJECT

PB-Vicon Recovery Systems, proposers to the City for the Materials Recovery/ Waste Conversion Facility, have informed us that page 6 of their Executive Summary contains a typographical error they wish to clarify. The phase "for direct operating costs and $2-3 million (1982 dollars) for debt service" was inadvertently omitted from the second sentence of the first paragraph on that page.

Attached is a revised copy of page 6 containing the proper language. This should be substituted for the original page 6 in the Executive Summary. Please note that this is an omission of a line in an information item, and in no way affects their proposal to us.

cc: Assistant Director of Public Works
Auditor
City Clerk
Agenda Coordinator

2. Operations and Maintenance Cost

The operating cost of the facility will consist of labor, utilities, sinking fund payments, maintenance, insurance, taxes, residual disposal (process ash), landfilling, land lease, administration and debt service. The sum of those items as currently estimated is $2.3 million (in 1982 dollars) for direct operating costs and $2-3 million (1982 dollars) for debt service for a facility to process 86,400 tons/year and transfer up to 57,600 tons/year to landfill.

Unless fixed (e.g., debt service), each cost item will escalate over time. If such escalation is not the result of actual increases in published data (e.g., electrical rate increases), one of two indices can be used to estimate increases:

Index A - Labor Index:	Employment Cost Index for Wages and Salaries for West Region, Bureau of Labor Statistics.
Index B - Material Index:	Producer Price Index, Bureau of Labor Statistics.

C. FINANCING

PB-Vicon proposes to finance the design and construction of the MR/WCF through a combined leveraged lease/joint venture structure.

The advantages of this structure are significant:

a) It would provide committed funds in advance, making the proposal attractive.

b) It would minimize the need for equity and much of the working capital from the developer, lowering facility cost.

c) The implicit cost of financing, and therefore the minimum annual finance charges, will be as low as possible, because of the use of applicable tax credits to private investors.

d) No City financing, funds or guarantees would be required.

e) It should provide a flexible proposal that should be comparatively inexpensive to arrange because of the small number of participants involved.

f) There would be a minimal amount of non-productive reserves.

g) Except in rare instances, having a financial institution as a joint venture partner should either eliminate the need or greatly facilitate the arranging of construction financing.

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PB-Vicon Recovery Systems

October 15, 1982

Mr. Michael J. Baumann, Project Manager
Department of Public Works
City of Berkeley
2180 Milvia Street
Berkeley, California 94704

Dear Mr. Baumann:

We are pleased to submit this proposal to the City of Berkeley for the design, construction, operation, financing and ownership of the Materials Recovery/Waste Conversion Facility (MR/WCF). Our joint venture, comprised of Vicon Recovery Systems, Inc. and Parsons Brinckerhoff Development Corporation, possesses the full range of capability and experience to deliver to the City a facility which will reinforce its current recycling efforts and extend them with the new dimension of energy recovery.

The PB-Vicon team proposes to implement a waste-to-energy system to process the targeted amount of 72,000 tons/year with the ability to process up to 240 tons/day. The same technology, developed by Enercon Systems, Inc. of Cleveland, has been operating successfully for over a year at Pittsfield, Massachusetts. We offer dependable, rugged technology and are prepared to stand behind it.

In preparing our proposal, we have had several discussions with local energy and material customers, private haulers, landfill operators and environmental leaders. We were greatly impressed with the dedication shown to resource recovery and recycling. We hope that our facility will enhance the program, and we have included in our proposal a specific front-end separation system to increase the yield of material recycling. In the implementation process, we intend to cooperate fully with those involved in the recycling program.

We look forward to working closely with the City to make waste-to-energy a reality in Berkeley. We are fully committed to recycling and resource recovery, and we know that Berkeley is also. The facility that can result from our joint efforts will reflect that commitment and give the City a leadership position in the nation's resource recovery arena.

Very truly yours,

PB-VICON RECOVERY SYSTEMS

Joseph J. Domas

Joseph J. Domas, President
Vicon Recovery Systems, Inc.

David Seader

David Seader, Vice President
Parsons Brinckerhoff Development Corporation

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New York, New York 10119
Tel. (212) 239-7900

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LIST OF ILLUSTRATIONS

I. Introduction

This proposal is being submitted by PB-Vicon Recovery Systems in response to the City of Berkeley's request for a developer to design, build, own, operate and finance a materials recovery/waste conversion facility (MR/WCF), as well as to operate the solid waste receiving/transfer station (R/TS) now under construction. The purposes of the MR/WCF are to reduce the amount of refuse requiring landfill, to produce revenue from recovered materials or useful products and to reduce the net refuse disposal cost to the City.

PB-Vicon is pleased to be able to offer to the people of Berkeley a facility which will fulfill all of the City's objectives in a safe, sanitary and environmentally sound manner. The Berkeley MR/WCF will satisfy the City's goals in the following ways:

1. The tipping fee for waste delivered will be $17.20 per ton, held constant for the 20 year duration of the contract. In years when revenues increase faster than costs, the City will receive revenue sharing between 1 and 3 percent of gross electricity sales, further reducing net disposal costs. (See Section II, Cost).

2. The transfer station is being built with an average capacity of 400 tons/day (TPD), which would initially be transferred to landfill. The MR/WCF will have the capacity to process 240 tons/day. With the start of operation of the MR/WCF, the amount of tonnage going to the landfill will thus be cut by about 50 percent, the City's recycling goal. If the amount of tonnage arriving at the R/TS is reduced further, this will translate directly into reduced landfill tonnage and a higher percentage of waste recycled (see Section III, Description of Facility).

3. The MR/WCF will produce electricity for sale to PG&E from this "waste" fuel, thus eliminating the need for about 100,000 barrels of oil per year for 20 years (see Section III, Description of Facility).

4. The MR/WCF will produce up to 70 tons/day of potentially recyclable material for use by the existing recycling center. This represents 17 percent of the City's current waste flow and almost 30 percent of the MR/WCF processing capacity.

   All revenues for recycled materials will go to the recycling center. If only 25 tons/day of material is recycled by the center, this would represent a major recycling effort yielding significant revenues for the support of that program (see Section IV, Interface with Recycling).

5. The capital and operating costs of the facility will be borne solely by PB-Vicon through private financing. Costs will be repaid out of tipping fees and electricity sales. The City bears no financing costs or risks (see Section II, Costs).

6. The facility will be operated only if it passes its performance test, which will include compliance with all air emission control requirements. In the unlikely event that the facility does not perform, it will be removed at no cost to the City. PB-Vicon will then pay the City $1 million to find an alternative long-term disposal solution and will continue to operate the R/TS in the interim (see Section VII, Highlights of Contract Terms).

The facility being proposed for Berkeley is nearly identical to our plant in Pittsfield, Massachusetts, which has been on-line and running at full capacity for over 18 months. That facility has met or exceeded applicable environmental standards and has been operating with a reliability of almost 100 percent (see Section VIII, Additional Information).

II. Cost

A. COST TO THE CITY, INCLUDING REVENUE SHARING

1. General

For use in establishing the disposal price to the City and for setting revenue sharing amounts for the City, it is necessary to define two indices:

1) Operating cost index (OCI). This is a weighted index to track the escalation of the facility's variable costs over time.

2) Electricity Price Index (EPI). In any year, this is the weighted price of a kilowatt hour sold by the facility for that year.

2. Base Disposal Fee

The base disposal fee to the City for any tonnage received will be \$17.20/ton, which will be held constant over the lease term of the facility. For processing amounts different than the target 200 TPD (72,000 tons/year), two adjustments will be made:

a) C_A, if the amount of waste delivered by Berkeley is less than the targeted 72,000 tons/year (TPY). This adjustment reflects spreading of the facility's fixed costs over a smaller base throughput, and lowered electricity revenues.

$$C_A = (\$1,500,000 \times (1 + \Delta OCI)) - \frac{\$1,500,000 \times (1 + \Delta OCI) \times T}{72,000}$$

Where: T = actual tonnage delivered
ΔOCI = difference in the OCI from the base year (1982)

b) C_L, if the amount of waste delivered by Berkeley is greater than the targeted 72,000 TPY and such additional tonnage cannot be processed. This adjustment reflects a pass through of any increases in the cost of transfer-hauling waste to landfill. It will only apply to actual tonnage transferred to landfill.

$$C_L = (LF - \$8.75) + (\$4.00 \times \Delta OCI)$$

Where: LF = The tipping fee per ton at the landfill
ΔOCI = Difference in OCI from the base year (1982)

c) Summary:

The base price together with the two adjustments forms a scale of prices which is related to total tonnage received annually from Berkeley. In summary, this scale is as follows:

Annual Tonnage	Berkeley Disposal Fee (Annual)
$0 \leq T < 72,000$	$(Base \times 72,000) + C_A$
$T = 72,000$	$(Base \times T)$
$T > 72,000$	$(Base \times T) + (C_L \times T_L)$

Where: Base = \$17.20

T = Actual tonnage delivered
T_L = Actual tonnage landfilled
C_A = (as above)
C_L = (as above)

d) Examples

To clarify the equation, three examples are offered, for throughput rates of:

1) 100 TPD = 36,000 TPY
2) 200 TPD = 72,000 TPY
3) 300 TPD = 108,000 TPY

For these examples, assume the OCI has increased 5 percent; that the landfill tipping fee has risen to \$9.00/ton.

Example (1): 36,000 TPY
Price = $(Base \times 72,000) + C_A$

$$= (17.20 \times 72,000) + \$1,500,000\ (1.05) - \frac{\$1,500,000\ (1.05) \times 36,000}{72,000} = \$2,025,900$$

Example (2): 72,000 TPY
Price = (Basc x T) = \$17.20 x 72,000 = \$1,238,400

Example (3): 108,000 TPY
Price = $(Base \times T) + (C_L \times T_L)$

$$= (\$17.20 \times 108,000) + (\$0.25 + \$0.20) \times 36,000 = \$1,873,800$$

3. Revenue Sharing

It is proposed that the City share fully in the productive electricity output of the facility. This means that as electricity prices increase, the City will share in those enhanced revenues. The revenue sharing formula has been designed so as to increase the City's snare of revenues depending on how much the escalation of electricity revenues outstrips the escalation of the facility's costs.

In any year, however, when the cumulative increases in costs exceed the cumulative increase in electricity prices, revenue sharing will not occur. For this purpose, we define the ratio of price increases to cost increases as follows:

$$R = \frac{\Delta EPI}{\Delta OCI}$$

Where: ΔOCI = Percent of change in OCI from the base year (1982)
ΔEPI = Percent of change in EPI from the base year (1982)

Then, in years in which R is equal to or greater than one, revenue sharing will take place.

In summary, the following revenue sharing is proposed:

Ratio Value	Revenue Share as a Percentage of Gross Electricity Sales
$0 \leq R < 1$	0%
$1 \leq R < 3$	1% x R
$R \geq 3$	3%

This means that the City's share of gross revenues varies from 1 to 3 percent depending upon the relative behavior of electricity prices and facility costs. An example will help. Assume that in the base year, gross electricity sales were $3,000,000. In the following year, EPI rose by 10 percent; OCI by 5 percent. The ratio (R) is 2. The revenue sharing percentage is 2 percent. The City's revenue share in that year is 2 percent of the new gross ($3,300,000), or $66,000. This means that of the increase of $300,000 in revenues, the City gets 22 percent, while the remainder goes to pay PB-Vicon's increases in costs as well as its return.

B. CAPITAL AND OPERATING COSTS

1. Capital Cost

The capitalized construction costs of the proposed facility are estimated at $19-20 million as follows:

a. Direct Construction Costs -- $12,850,000.

b. Construction Interest -- applied against the construction schedule. Current rates are about 15 percent per annum on outstanding balances, but such rate will be dependent upon money market conditions at the time the construction loan is taken.

c. Developer's overhead and project management allowance of 10 percent of total development costs.

d. Financing fees, including legal and accounting fees, placement costs, etc. -- estimated at 3-5 percent of total development cost.

e. A working capital allowance of $500,000 to cover contingencies, cash flow variations and initial revenue operations.

2. Operations and Maintenance Cost

The operating cost of the facility will consist of labor, utilities, sinking fund payments, maintenance, insurance, taxes, residual disposal (process ash), landfilling, land lease, administration and debt service. The sum of those items as currently estimated is $2.3 million (in 1982 dollars) for a facility to process 86,400 tons/year and transfer up to 57,600 tons/year to landfill.

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III. Description of Facility

A. GENERAL PROCESS DESCRIPTION

1. Receiving

After weigh-in, commercial and city collection vehicles will enter the transfer station through doors on the south side, unload and proceed to the 2nd Street exit.

Public vehicles will proceed past the scale house and unload at the east side of the transfer station under the building canopy.

Weekend traffic indicates a need for additional public unloading areas; therefore, portable dividers will be repositioned allowing additional public access to city and commercial areas.

Vehicles containing known sources of waste will be directed to specific unloading doors, so that waste may be categorized to assist in effective blending and preseparation for recycling.

2. Refuse Movement and Loading

All refuse will be unloaded within the transfer station. Front end loaders will segregate waste for separation and reclamation. Oversized recyclable materials will be temporarily stored in rolloff bins within the transfer station. The remaining refuse will be blended and transported to incinerator loading hoppers by front end loaders.

Ash from the incinerator discharge will be deposited in rolloff bins located in the ash handling area of the facility. These containers will be loaded on trailer transfer carriers and dumped at the appropriate landfill.

The tractors supplied by the transfer station contractor will be coupled with special trailers and give a great degree of versatility to the material movement system. Transfer trailers supplied by the transfer station contractor will be utilized for bulk material recycling.

Operating experience at the Pittsfield facility indicates that reject materials including white goods, oversize wood and stumps, scrap steel, and iron casting and other large metallic materials comprise 2.5 percent of the incoming waste stream.

3. Processing

The MR/WCF proposed by PB-Vicon for the City of Berkeley represents the best technology that can be applied to the solution of problems attendant to disposal of 150-750 TPD of municipal solid waste and the production of usable thermal energy. The process features the economic advantages that an energy recovery program can offer as well as providing for maximum reduction of volume through combustion with sanitary landfilling for final disposal of waste material (ash and rejects).

The process illustration (following) depicts the transfer of the "as received" waste from the transfer station tipping floor to the primary combustion chamber with the utilization of a standard rubber tired front end loader. The loader operator is responsible for selecting a balanced stream of waste and charging the automatic ram loader on a timed cycle. The waste is advanced through the primary combustion chamber with the residual (ash) discharged to a quench trough for conveying to a rolloff container for transport to a selected landfill. The gases exiting the primary chamber enter the secondary chamber where a complete combustion of any gas entrained particles is accomplished under controlled temperature conditions. The gas continues through the tertiary chamber, where mixing with recirculated flue gas provides final control of the temperature prior to introduction to the waste heat boilers. The outlet of each waste heat boiler is directed to emission control devices designed to satisfy the equipment requirements, standards and monitoring requirements of the Bay Area Quality Management District (BAAQMD). (See Section V.)

The superheated steam produced in the waste heat boilers is directed to the throttle of a turbine generator set for the production of electrical energy for sale to Pacific Gas & Electric Company. Condensate from the turbine will be directed to the boiler feedwater system for recycling.

The residue ash will be 25 percent by weight of the incoming MSW. The residue ash will consist of all inert material present in the incoming MSW in addition to 3 to 4 percent unburned carbon.

The waste flow diagram on the following page traces the path of material through the system on an average day. The MR/WCF will be added to the Receiving/Transfer Station (R/TS), which is sized to accept the current 400 TPD average. The R/TS becomes the tipping floor for the materials and energy recovery plant.

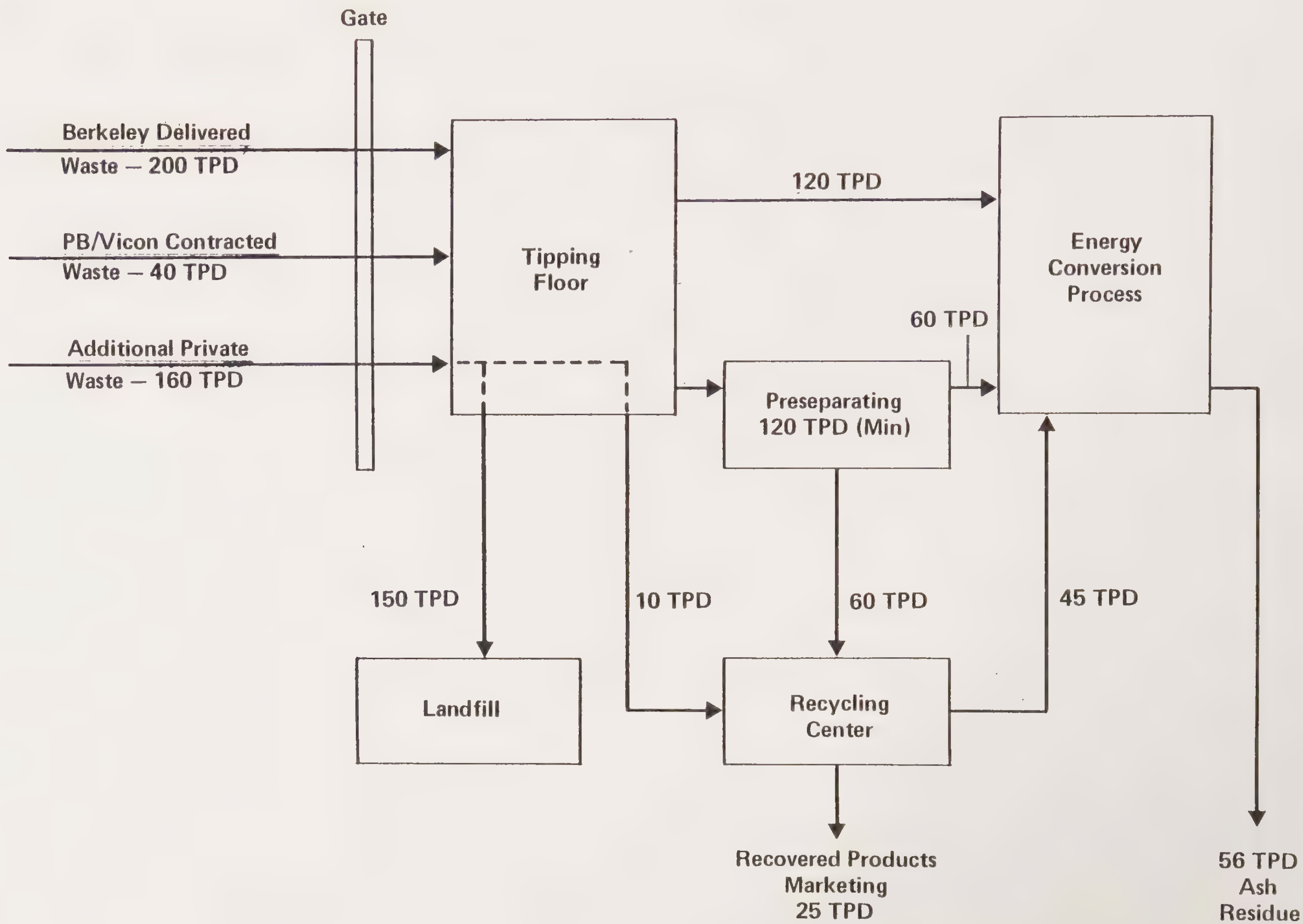
B. BASIC TECHNOLOGY AND EQUIPMENT

1. <u>Process Equipment (see floor plan)</u>

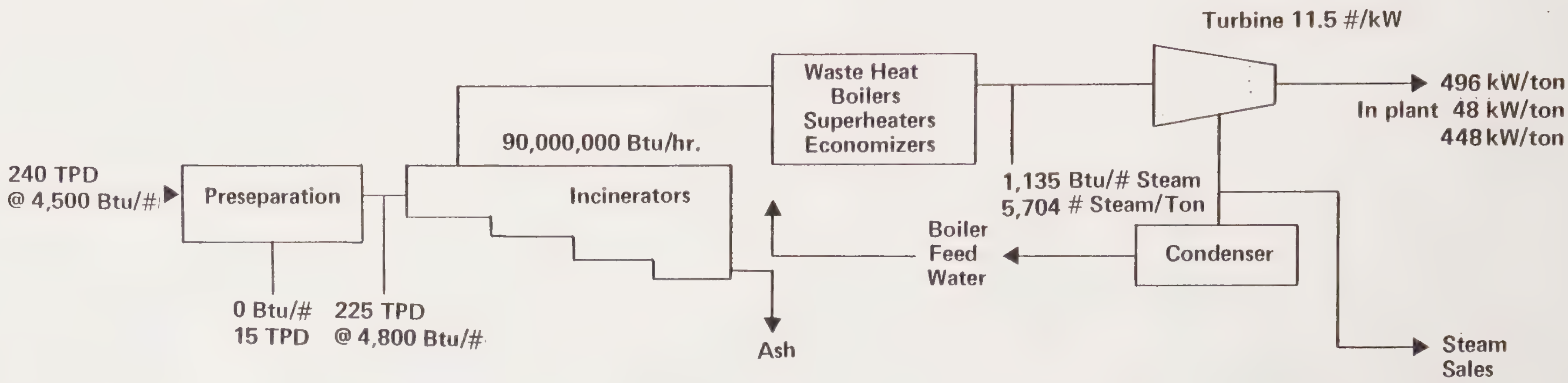
a. Furnaces - Three furnaces are rated at 120 TD. The plant will have two furnaces on line, and one standby. Features of the furnaces include controlled overfire and underfire airflow, large loading ram, and water cooling of steel components. Dual fuel burners, accepting gas or oil, located in the primary chambers (the lower rectangular portion of the furnace) provide initial ignition of refuse. These are turned off after the fire is established.

b. Manifold or Tertiary Chamber - This chamber receives hot gases from the furnaces and connects to the waste heat boilers (WHB). Guillotine dampers serve to isolate each furnace, boiler and bypass stack. The normal flow is from any one furnace to either WHB, or from any two furnaces to both WHB's. Emergency heat dump or burning without heat recovery is through the bypass stack.

c. Waste Heat Boilers - These boilers are rated at 35,000 lbs hr. Each is designed to operate with flue gases entering at a temperature up



Waste Flow Diagram	**PB-Vicon Recovery Systems** 10 Park Place, Butler, NJ One Penn Plaza, New York, NY	City of Berkeley **Waste Recovery Facility** Berkeley, CA

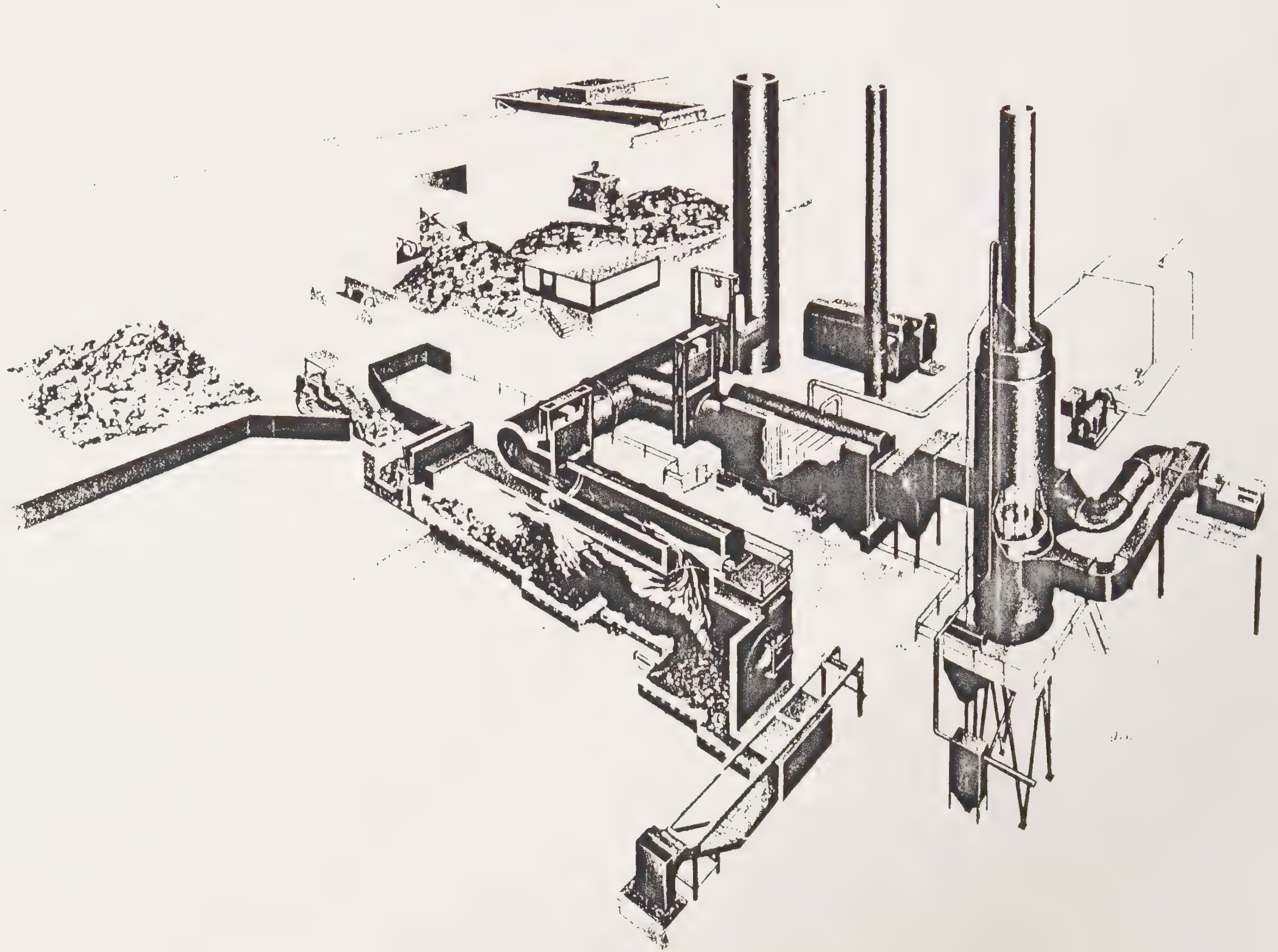


Cal Ink
@ 150 psi &
$10^{o}F$ Superheat

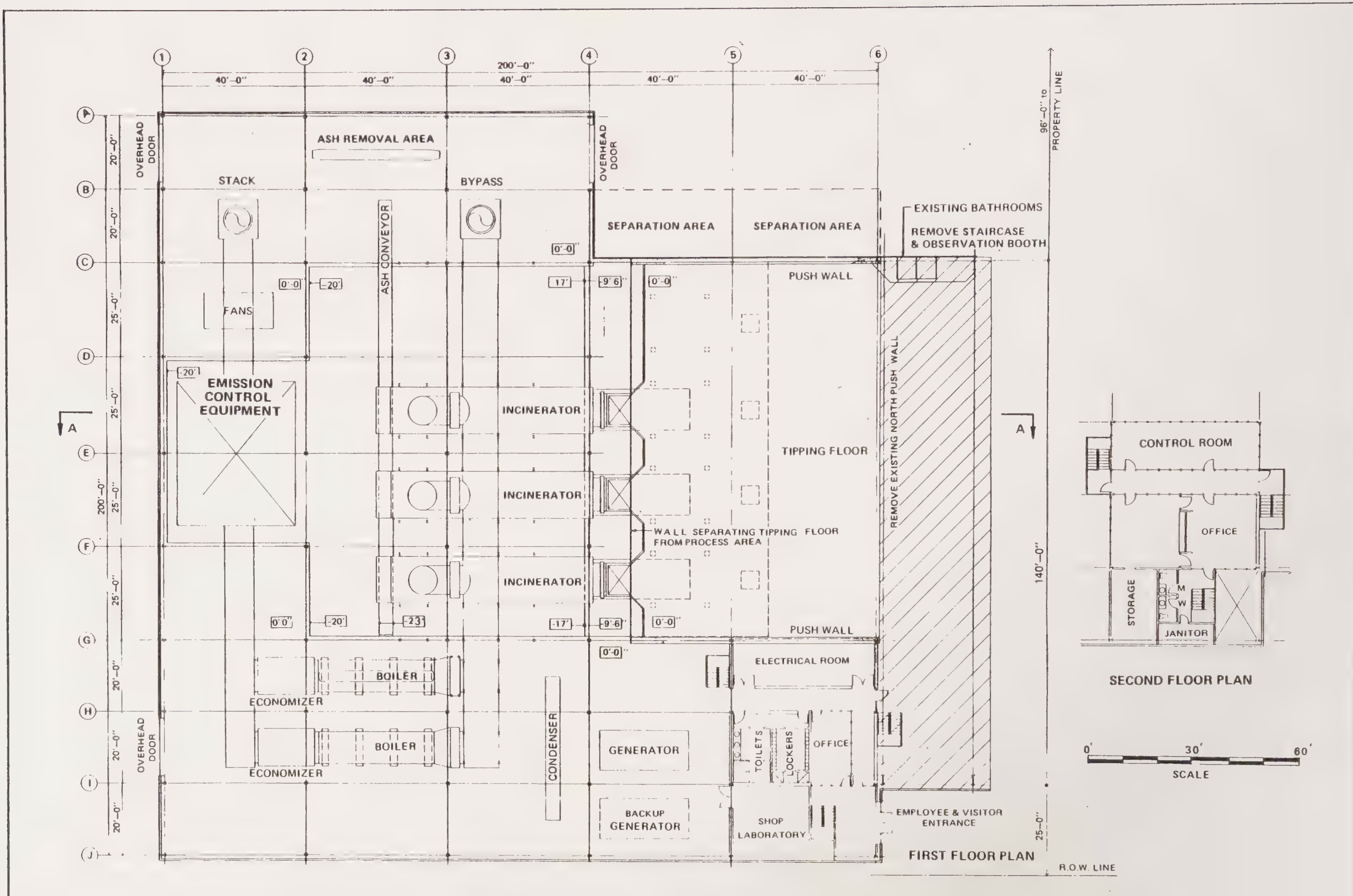
68% Efficiency (System)

Total Electrical Output
225 TPD x 448 kW/ton = 4,200 kW (Continuous)

Energy Balance Flow Diagram	PB-Vicon Recovery Systems 10 Park Place, Butler, NJ One Penn Plaza, New York, NY	City of Berkeley Waste Recovery Facility Berkeley, CA



Vicon/Enercon Process	PB-Vicon Recovery Systems 10 Park Place, Butler, NJ One Penn Plaza, New York, NY	City of Berkeley Waste Recovery Facility Berkeley, CA



Floor Plans	**PB-Vicon Recovery Systems** 10 Park Place, Butler, NJ One Penn Plaza, New York, NY	City of Berkeley **Waste Recovery Facility** Berkeley, CA

to 1800°F, and then generate superheated steam. Compressed air soot blowers are installed with automatic controls.

d. Economizers - These serve to heat water before it enters the boilers, while reducing flue gas temperatue to 350° - 400°F.

e. Induced Draft Fans - Driven by 250 hp motors, they provide suction to pull gases through furnaces, boilers and economizers, and push gases through electroscrubbers.

f. Emission Control Devices. See Section V.

g. Ashes - The ashes are conveyed from the bottom of the water quench trough, up the incline, into the dumpster, and then transported to the landfill. Final ash volume is less than 10 percent of what enters the plant. Quench water used in the ash trough comes from the continuous blowdown, so that make-up water for quench, and overflow to the sewer, amounts to almost nothing.

h. Auxiliary Generator - This generator, driven by V-16 diesel engine and rated at 500 kW, is designed to carry one furnace, WHB line and auxiliary equipment in the event of a power failure at the utility company.

2. Structures and General Layout (see site plan and perspective drawing)

a. General Layout. The waste conversion facility will occupy the area north of the transfer station. The access road will be adjacent to the north side of the facility and connect to the public area on the east. Administrative offices will be constructed within the maintenance building on the second floor as provided by the transfer station contractor.

b. Integration with Transfer Station. The waste conversion facility will be constructed adjoining the north wall of the transfer station. The wall dividing the two structures will be removed providing an extended storage, loading area and machinery access to incinerator loading hoppers. Observation will be from the new office/control room complex within the waste conversion facility.

c. Process Building. The building shall be constructed on cast-in-place concrete foundations designed to accommodate the waste conversion equipment. Above-grade construction will consist of a steel frame enclosed within a prefinished metal wall panel system with an interlocking metal roof.

The resource conversion facility will be approximately 30,000 square feet, with two 30-foot-high overhead doors to serve the ash removal equipment and one 20-foot-high overhead door for general deliveries. The employees and visitors entrance will be at the southwest corner of the resource conversion facility, where the operations office and control room complex is located.

All process equipment will be contained within the 30,000 sq. ft. building. The waste handling area will be segregated from the process equipment and combustion air will be drawn from the handling area, therefore eliminating unpleasant odor discharge from the facility.

The refuse conversion facility will be equipped with skylights for natural lighting and highbay and fluorescent lighting fixtures to maintain adequate lighting levels at all times. Fire protection will be through the use of automatic sprinklers, hose stations and locally mounted extinguishers. Waste handling areas will be constructed of hardened concrete floors and concrete pushwalls with steel liners to direct waste flow.

d. Administration Building. The second floor of the maintenance building will serve as the administrative offices. This area will be constructed so as to provide a private office, storage room and general administrative area. Additional office and conference room facilities will be provided at the operations control room complex of the waste conversion facility.

e. Streets and Parking. Streets and roads constructed by the transfer station contractor will remain intact and only the public exit north and east of the transfer building will be realigned for construction of the waste conversion facility. Additional parking for 12 automobiles will be provided east of the waste conversion facility along the realigned public exit.

Entrance and exit to the ash handling area and the waste conversion facility delivery entrance will utilize the realigned roadway.

C. OPERATIONS

1. Procedures

The facility will be operated on a 24 hours a day, 7 days a week basis to satisfy the requirements of the City of Berkeley and the power sales agreement with Pacific Gas & Electric Co.

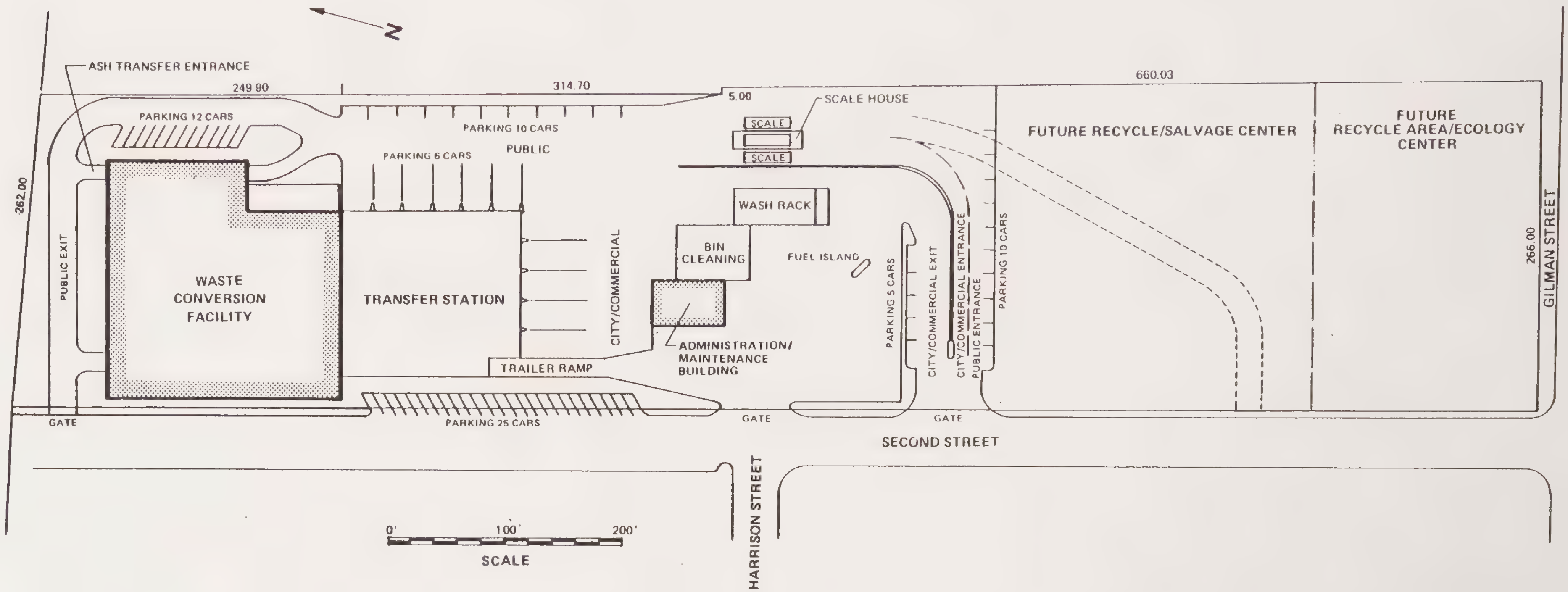
To achieve this continuous operation with 98 percent availability, PB-Vicon proposes an operational and maintenance procedure with proven results at our Pittsfield facility.

The procedure includes the following:

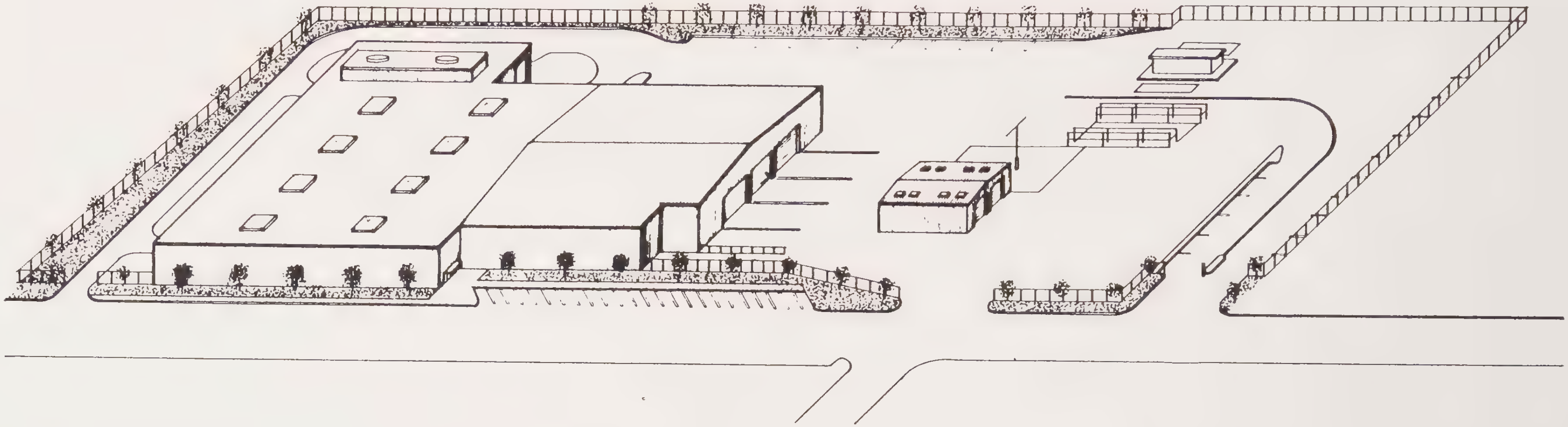
a. Three (3) eight (8) hour shifts, per day, seven (7) days a week.

b. One (1) week annual shutdown for major maintenance and repairs to the combustion equipment, generating equipment and the ancillary equipment.

c. Scheduled periodic inspection and maintenance, two (2) days duration, for each of the two boiler trains, to allow for deslagging and minor repairs. Production is maintained at approximately a 20 percent reduction for this duration.



Site Plan	PB-Vicon Recovery Systems 10 Park Place — One Penn Plaza Butler, NJ — New York, NY	City of Berkeley **Waste Recovery Facility** Berkeley, CA



Perspective	**PB-Vicon Recovery Systems** 10 Park Place Butler, NJ One Penn Plaza New York, NY	City of Berkeley **Waste Recovery Facility** Berkeley, CA

The 72,000 TPY facility incorporates two boiler trains. Production reduction is the result of one of the two boilers being removed from service for maintenance and inspection. The reserve capacity of the system will allow the second boiler to be fired at a higher rate, therefore resulting in a 20 percent loss of production during this maintenance period. Cleaning, deslagging and inspection will occur every four weeks when one unit will be shutdown for 1.5 days.

2. Personnel

		Description	Req'd
Shift Engineer(s)	-	Responsible for plant operation during designated shift	4
Front End Loader Operator(s)	-	Responsible for operation of front end loader, metals sepa-ation and charging (batching) of waste	6
Maintenance Mechanic(s)	-	Responsible for daily maintenance of equipment including lubrication, seal(s) inspection and replacement front end loader(s), servicing and misc. repairs	4
General Utility	-	Responsible for misc. maintenance and repairs to equipment, building and grounds	5
Scale Master Clerk	-	Responsible for identifying and recording individual deliveries of waste, general filing and vehicle registration	2.5
Plant Superintendent	-	Responsible for overall facility operation and performance	1
Administration Assistant	-	Responsible for general corres-pondence, procedural reports, etc.	1.5
		Total Personnel	24

D. SERVICES OFFERED

1. Permitting

The permits identified and required for the design and construction of the MR/WCF will be obtained solely at PB-Vicon's expense.

PB-Vicon intends to retain an area consultant familiar with the local, state and federal regulations and codes governing the design and construction of the facility.

2. Design and Construction

Vicon Recovery Systems, Inc. (VRS) of Butler, New Jersey, will have overall responsibility for the process design and construction of the project and the manufacturing, procurement and installation of process equipment. Construction development management and supervision, as well as construction equipment and manpower will be provided by a regional, experienced construction company under a bonded contract agreement. Parsons Brinckerhoff Quade & Douglas, Inc. will provide engineering and architectural services relative to the project building and appurtenances. Enercon Systems, Inc., Cleveland, Ohio, the designer of the major combustion equipment components of the project, will provide the process design.

3. Project and Construction Management

PB-Vicon Recovery Systems has assembled a team consisting of Vicon Recovery Systems, Inc.; Parsons Brinckerhoff Construction Services, Inc., and Enercon Systems, Inc. Each of these firms has specific expertise relevant to this project. The team has completed the construction management of several similar energy-related facilities.

This team will run the project, and will draw on internal staffs as required. The corporate contracts, purchasing, and accounting staffs will have personnel assigned specifically to this program to provide prompt and accurate action and information.

Overall project management logically breaks down into design, construction, and operation tasks. Because PB-Vicon is the designer, builder and the operator, particular attention will be paid during design, construction, and start-up phases to ensure adequate training of all personnel, and adequate input of operational considerations during design and construction.

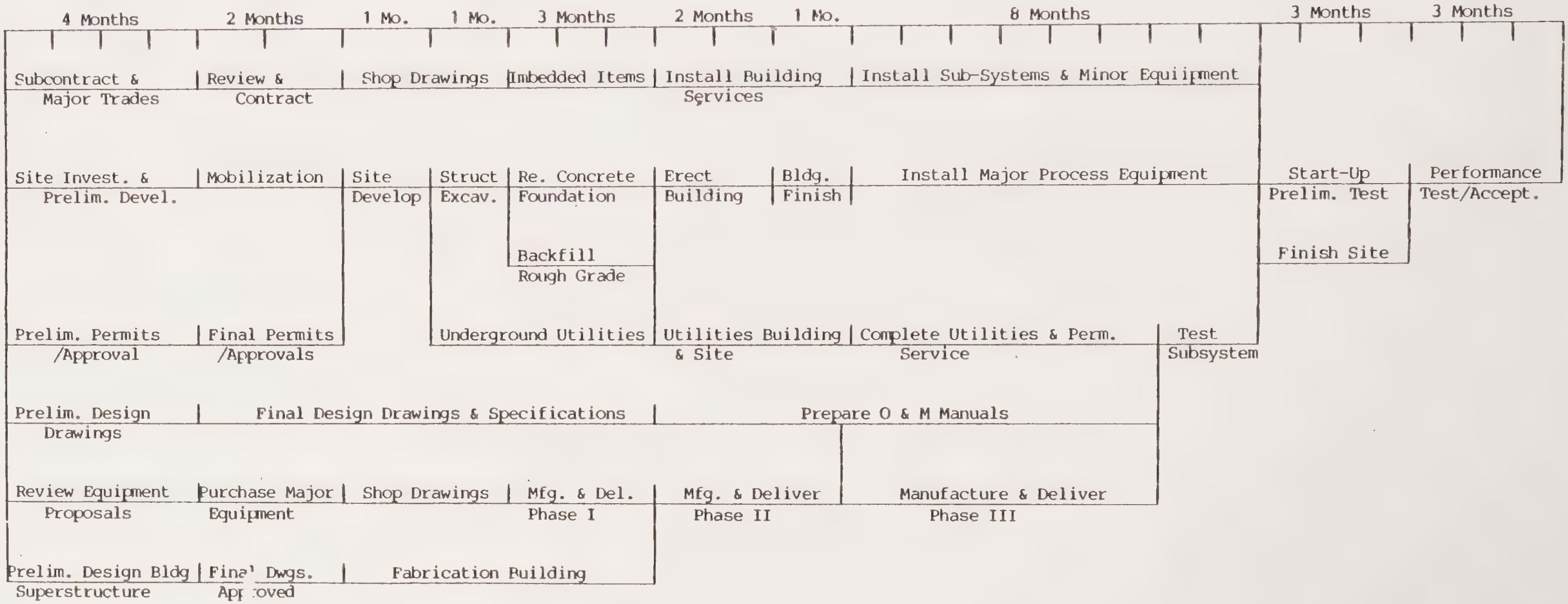
4. Full Scale Operation

Full scale operation shall commence during the shakedown and testing period. All operating personnel shall be in place prior to completion of the testing program and during the commencement of full scale operation.

Transfer station employees shall be utilized to their full capabilities within the new combined facility.

5. Project Schedule

Vicon envisions construction of the proposed facility to be completed in approximately 28 months from award of the formal contract. Actual full operation would begin 6 months subsequent from that date following a 3 month shakedown period and a 3 month testing and start-up period. A specific refined schedule will be developed based upon the award date. Additional scheduling details are illustrated on the schedule diagram which follows.



Material Recovery — Waste Conversion Facility **Time Duration — 28 Months**	**PB-Vicon Recovery Systems** 10 Park Place, Butler, NJ One Penn Plaza, New York, NY	City of Berkeley **Waste Recovery Facility** Berkeley, CA

IV. Interface With Recycling

Plant personnel will segregate large or irregular shaped metals, white goods, containers and noncombustible materials from the waste stream on the tipping floor for transfer to the recycling center. Such oversize materials are estimated to be 10 TPD. From the tipping floor, 120 TPD will be sent directly to the energy conversion facility and 120 TPD will be first preseparated for recycling. As more experience is gained with the preseparating equipment, more waste will be sent through the preseparation process.

Preseparation will yield 60 TPD (50 percent of the 120 TPD as a burnable fraction and 60 TPD as a recyclable fraction). The 60 TPD of recyclables plus the 10 TPD of oversize materials will be sent to the Recycling Center for its use in reclaiming marketable products. Any materials not extracted by the Recycling Center will be returned to the energy conversion facility. PB-Vicon has estimated that 25 percent of the recyclable fraction could be reclaimed -- 15 TPD -- plus the entire 10 TPD of oversized materials, yielding a total of 25 TPD of recycled materials.

The remaining 150 TPD will bypass the facility and be transferred to landfill. If the total amount of waste decreases from 400 TPD, less waste than 150 TPD will be landfilled.

All revenues for recycled materials will go to the Recycling Center, less a handling charge to PB-Vicon of $1.00 per ton of material recycled. Thus, the "revenue" to the MR/WCF for recycling is estimated to be $9,000 in the first year. Revenues to the Recycling Center for the materials will be many times the handling charge.

V. Air Emissions

A. EMISSION ESTIMATES

The following estimate of air emissions is based on solid waste characteristics of material presented in the RFP. The assumed processing rate will be 86,400 tons per year with a maximum daily rate of 240 tons. Combustion controls, electrostatic precipitators and dry gas scrubbing equipment will be utilized to attain these controlled values.

ESTIMATED AIR EMISSIONS
FOR PB-VICON BERKELEY FACILITY

Pollutant Name	Tons/Year
TSP	18*
SO_2	10
CO	24
NO_x	21
HCL	20*
Hydrocarbons	19
Beryllium	0.0004*
Lead	2.6*
Mercury	0.096*
Asbestos	0.001*

*Based on actual tests conducted at Pittsfield, Massachusetts.

B. DESCRIPTION OF EMISSION CONTROL DEVICES

Each waste heat boiler train will be provided with emission control devices which will control the emissions from the system to the degree necessary to meet the Bay Area Pollution Control District's Rules and Regulations.

The emission control system will incorporate particulate, HCL and SO_2 removal equipment. Particulate matter generated by the combustion of MSW will be minimized by the design of the processing equipment and the combustion air control system, and controlled by the installation of an electrostatic precipitator (ESP). HCL and SO_2 will be controlled by a dry scrubber. The lime slurry dry scrubber process uses a slurry of hydrated lime to absorb acid gases from the flue gas by contact with atomized droplets of the alkali slurry. The atomized droplets evaporate rapidly to cool and partially humidify the hot flue gas, thereby reducing the effective plume rise.

Minimal process development is required for this system as it combines two technologies - spray drying and electrostatic precipitation - which have already had wide commercial application.

1. Dry Scrubber

Two dry scrubbers will be utilized to control gas emissions from the facility. Flue gases exiting boiler economizers will pass through high

temperature duct work and enter the reactor vessel. A lime slurry is introduced into the reactor and the chemical process previously described takes place.

2. Electrostatic Precipitator

Two individual electrostatic precipitator systems will be installed at the resource recovery facility. Flue gases leaving the dry gas scrubber will pass through duct work into the distribution chamber of the electrostatic precipitator. Particles entering the precipitator are electrically charged and collected on precipitator collection surfaces. Rapping of the collection surfaces discharges materials into the collection hopper. Screw conveyors will transport this material to the residue conveyor for final disposal. A four field system will be utilized to satisfy the air quality requirements.

VI. General Environmental Considerations

A. LITTER

All materials spilled or dribbled from incoming or outgoing vehicles will be promptly removed by plant cleanup personnel. Sweeping of roadways will be completed on a daily basis. Cleanup personnel will remove all windblown litter from the facilities grounds daily. All vehicles with open tops will be required to utilize tied down mesh to cover loads.

B. ODOR

Tipping floor storage areas shall be kept at a negative pressure to prevent odors from escaping outside. This will be accomplished by utilizing waste handling areas as a plenum for process equipment combustion air blowers. Additional control will be maintained through regular sweeping of tipping floor. The waste conversion facility process equipment will not produce an unpleasant odor, therefore eliminating the need for any additional equipment.

C. WASTE WATER DISPOSAL PLAN

Waste water and sewerage shall be collected within the facility and disposed of through the E.B.M.U.D. sewer system. Waste water generated at the facility will consist of 4,000 to 5,000 gallons per day of sanitary and wash water only. Process and boiler blowdown waste water will be utilized for ash quench makeup. The sanitary and washdown water discharge lines will be connected to the municipal sanitary collection system. All discharge into the community sewer system shall meet permissible discharge requirements.

D. STORM DRAINAGE

The storm waste system shall collect drainage water from roadways and roofs for deposit in the municipal drainage system.

E. DUST

Dust will be confined to the incinerator loading areas where air sweeping will be utilized to maintain control. Air sweeping shall incorporate a collection system that directs dust laden air into the incinerator combustion air flow. Sweeping shall utilize a waterspray to minimize airborne materials.

F. VECTORS

All areas of the facility will be accessible for cleaning therefore eliminating any nesting areas for rodents and insects. Tipping floor and yard areas will be cleaned daily. Spraying for insects and traps for rodents will be maintained for additional control.

G. VISUAL EFFECTS

The building design will incorporate a metal wall panel system that will be color coordinated with the existing transfer station facility. Landscaping

will be chosen and placed to enhance the facility's view from 2nd Street. A new visitor and employee entrance at 2nd Street shall incorporate an attractive and functional courtyard area for the neighborhood. All process equipment shall be contained within the process equipment building and create an aesthetically pleasing facility.

H. NOISE

Noise from rolling equipment will be minimal with effective preventive maintenance performed. Front end loaders will operate within the building, further reducing any noise transmission. Process equipment shall be enclosed by the building system eliminating any sounds generated from the waste conversion facility.

I. FOSSIL FUEL REQUIREMENT

The fossil fuel requirement is limited to a twelve (12) hour preheat and three (3) hour cooldown required for the annual plant shutdown. The BTU input for both operations is 10×10^6 BTU/hr. Equipment will be oil or gas fired.

VII. Highlights of Contract Terms

A. PERFORMANCE GUARANTEE PROVISIONS

PB-Vicon warrants that all equipment components and accessories will be free of defects in materials and workmanship for a period of twenty-four (24) months after startup and acceptance.

PB-Vicon will specifically agree to the following:

a. It will be fully responsible for processing the guaranteed tonnage or providing an alternative sanitary means of disposal after passing the performance test or after 36 months, whichever comes first.

b. It will reduce the weight of waste processed by 75 percent on an annual basis.

c. It will maintain the operability of the R/TS and its rated capacity, after PB-Vicon acceptance.

d. It will meet all applicable environmental standards in effect at the date of the contract.

e. It will charge the City only the price specified in the contract for waste disposal, if there are no material changes in applicable laws, standards or regulations.

B. FAILURE TO MEET PERFORMANCE GUARANTEES

PB-Vicon proposes to provide waste disposal services under its cost proposal at a date certain, regardless of whether the facility passes its performance test.

At the end of 36 months, PB-Vicon will begin assuming responsibility for the City's 400 TPD (average) of waste under its contract. If the facility has been accepted by then, revenue service will begin as anticipated. If not, PB-Vicon will have an additional 18 months to pass the test. If, at the end of the 18 months, the facility has not passed its performance test, PB-Vicon will have two options: (1) abandon the plant, and (2) operate a de-rated facility. If PB-Vicon chooses abandonment, it will remain in place for an additional 18 months while the City finds an alternative solution. PB-Vicon will then remove the facility (under a demolition bond) and pay the City $1 million to cover its costs. Should PB-Vicon choose to operate a de-rated facility, the City has the option of finding an alternative solution. Should the City choose to exercise its option, PB-Vicon will be required to remove the facility and pay $1 million to cover City costs.

C. PENALTY FOR FAILURE TO REDUCE WASTE BY WEIGHT

PB-Vicon has guaranteed that it will process 72,000 TPY of "acceptable" waste with a weight reduction of at least 75 percent of the weight of the "as received" waste. If total weight reduction on the targeted amount is below 75

percent (on an annual basis), PB-Vicon will pay the City $1.00/ton for each ton in excess of the amount guaranteed. The $1.00/ton penalty will be escalated each year, starting from the first year of operation, by the percentage change in the OCI (the cost index defined in the cost proposal) from the previous year.

D. SECURITY FOR PERFORMANCE GUARANTEES

PB-Vicon will secure the performance of its plant by furnishing a $1 million bond (or equivalent security) for faithful performance as well as the demolition bond requested in the RFP. All major subcontractors will furnish 100 percent Performance and Payment Bonds which will remain in effect through facility acceptance; all major equipment items will be covered by manufacturer's warranties. To further assure all parties concerned, PB-Vicon proposes to secure a Performance Insurance Policy.

VIII. Additional Information

Resource Recovery

Pittsfield Is Recovery Success Example


VICON'S resource recovery facility in Pittsfield, Massachusetts.

By **Joseph J. Domas**

RESOURCE recovery — its technological track record in the United States has been decidedly mixed. Over the past decade, failures have certainly outnumbered the triumphs. Unfortunately, we have seen the promise of waste-to-energy technology go largely unfulfilled.

Along the way, however, there have been successes. One such example is the Pittsfield, Massachusetts, resource recovery facility, completed in March 1981. Refuse-derived energy has been generated from the facility for a year and early indications point to a future of smooth operation.

The move in Pittsfield from landfilling to resource recovery didn't come about overnight. It was the product of several years of hard work, study and negotiations on the part of the city, the energy customer (Crane Paper Company) and Vicon Recovery Systems, developer and operator of the facility.

In the early 1970s Pittsfield — a city of about 55,000 — found itself in a position similar to countless cities and towns across the nation: it was running out of landfill space. The existing landfill was nearing capacity, and sites for future landfills were nonexistent. A Solid Waste Commission was appointed by the mayor to investigate waste disposal alternatives. It decided in 1976 to move in the direction of a modular controlled-air refuse-to-energy system. The plan called for steam production and sale to an energy customer, and for a full-service designer, builder, owner and operator of the plant.

In 1977, an independent engineering consultant confirmed the commission's recommendation; an RFP was issued in the spring of 1978. In August 1978, as a result of competitive negotiations, Vicon was selected as the full-service contractor. Construction began in September 1979, and full revenue service commenced 18 months later.

Underlying negotiations that led to the contractual agreement among the three parties — Pittsfield, Crane and Vicon — was the accomplishment of a "reasonable" distribution of costs and benefits. The cost to the city (tipping fees), the savings for the energy customer and profit for the owner/operator all had to be balanced, given current economic realities and future projections. Judging from the project's status, all parties feel they have gotten their fair share.

Project Site

The site consists of approximately five acres of land leased to the project by Crane Company. It is 4.5 miles from the center of the city and 1.2 miles from the existing sanitary landfill, which was closed to receiving new waste as of April 1981. A portion of the land was set aside for residue disposal and bypass capacity.

Particular features of the site include:

- Traffic flow designed to separate commercial traffic from private vehicles, providing safer access for private vehicles and a means of weighing the aggregate quantity received from noncommercial sources.
- Provision for collection of source-separated items, which encourages the community to actively participate in reycling of cans, glass, aluminum and paper.
- Litter control maintained by careful unloading procedures.
- An on-site detention basin to provide adequate stormwater storage in the event that runoff exceeded the capacity of the storm sewer line.

Processing Building

The processing building, which houses the receiving area and process equipment, is constructed with precast concrete components. The building is approximately 30,000 square feet in area and 31 feet high, with six doors to receive incoming trucks.

Waste is either deposited on the tipping floor, inspected visually and then pushed by front-end loader into the furnaces, or deposited into a 500-ton-capacity storage pit adjacent to the tipping floor. Waste from the pit is then transferred to the tipping floor for charging, using a 5.5 ton traveling bridge crane.

The entire system is run and maintained by an operator in a climate-controlled room with a clear view of all doors, the pit and tipping floor. Flow of waste into the system is directed through radio communication between the operator and the scale clerk.

Process Equipment

The plant consists of three furnaces, each rated at 120 TPD; two furnaces are on line, with one standby. Features of the furnaces include controlled overfire and underfire airflow, large loading rams and water cooling of steel components. Dual fuel burners, accepting gas or oil, located in the primary chambers (the lower rectangular portion of

the furnace) provide initial ignition of refuse. These are turned off after the fire is established. Burners at the end of the secondary chamber can be used to combust unburned carbon particles and assist with complete combustion of flue gases. In addition, they help maintain constant temperature of gases going to the waste heat boiler (WHB).

The manifold chamber receives hot gases from the furnaces and connects to the WHB. Guillotine dampers serve to isolate each furnace, boiler and bypass stack. The normal flow is from any one furnace to either WHB, or from any two furnaces to both WHBs. Emergency heat dump or burning without heat recovery is through the bypass stack.

Other process equipment includes:

• Waste heat boilers — manufactured by Bigelow of New Haven, Connecticut, and rated at 35,000 lbs/hr. Each is designed to operate with flue gases entering at a temperature up to 1,800° F and then generate superheated steam at 250 psi. Compressed air soot blowers with automatic controls have also been installed.

• Economizers — to heat water before it enters the boilers, while reducing flue gas temperature to 350-400 degrees Fahrenheit.

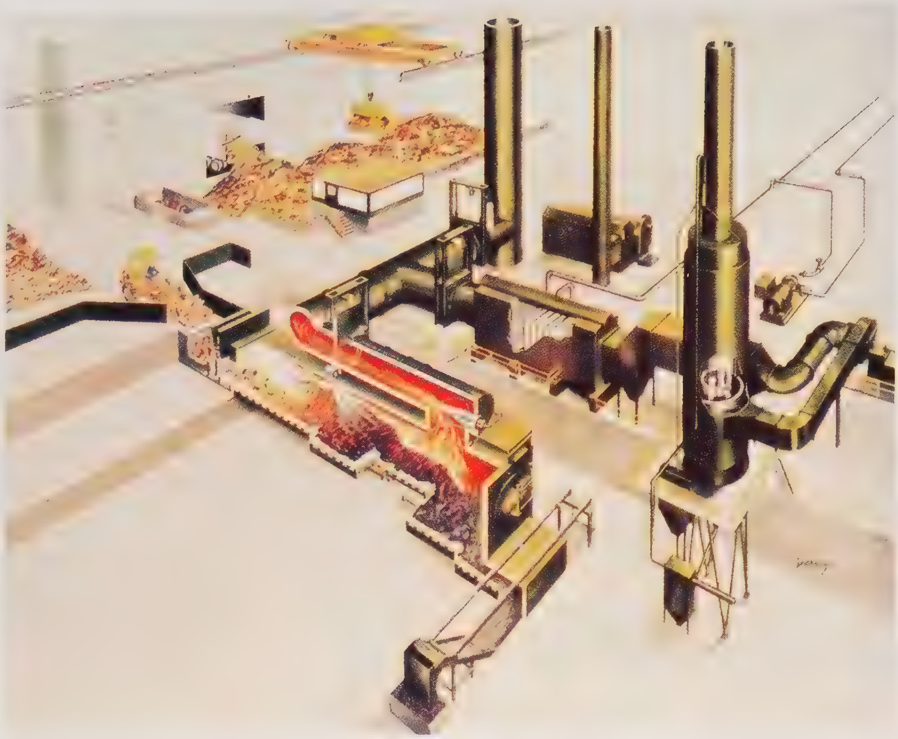
• Induced draft fans — driven by 250 hp motors, they provide suction to pull gases through the furnaces, boilers and economizers, and push gases through the Electroscrubbers.

• Electroscrubbers — designed by Combustion Power Equipment Co., a subsidiary of Weyerhaeuser. Flue gases pass through a circular bed of pea-sized gravel, which has an electrostatic grid to enhance the capture of sub-micron particles. The gravel is pneumatically conveyed to the top of the scrubbers, cleaned and then returned to the top of the gravel bed, where it is exposed again to the flue gases. Cleaned gases leave through the center stack of the circular gravel bed and then to the atmosphere.

• Auxiliary boiler — manufactured by Clever Brooks, this boiler fires #6 oil, and is rated at 35,000 lbs/hr. It is used if the waste system is down, to maintain guaranteed steam delivery to Crane Company.

• Auxiliary generator — driven by a V-16 diesel engine and rated at 500 kw, it is designed to carry one furnace, the WHB line and auxiliary equipment in the event of a power failure.

Ashes from the furnaces are conveyed from the bottom of the water quench trough, up the incline, into the roll-off container and then transported to the landfill. Final ash volume is less than 10% of what enters the plant. Quench water used in the ash trough comes from the continuous blowdown, so that make-up water for quench and overflow to the sewer amounts to almost nothing.



THREE furnaces, similar to the one shown here in an artist's rendering, make up the Pittsfield facility.

Water use comes to 120 gpm at full plant capacity. Because waster used to generate steam is an equivalent quantity of water not drawn off by Crane Company from the same main at their boiler house, there is no effect on the city water supply. Water is filtered, softened and then passed through the heat exchanger and deaerator tank before going to the economizer and WHB.

Energy Savings

The 240 TPD of refuse will generate about 1.2 million pounds of steam/day or 300 million pounds/year for a 250 days/year operation. This translates to approximately 2.6 million gallons of oil or 62,000 barrels of oil last year. Pittsfield's refuse alone (about three-fourths of plant capacity) is projected to be 44,000 TPY or the oil equivalent of nearly two million gallons. To relate this to the individual citizen, it means that the trash disposed of is converted to an energy equivalent of about one barrel per year or just under a pint of oil per day.

Financing for the $10.8 million dollar project was put together from a combination of public and private sources. The city of Pittsfield issued a $6.2 million industrial bond offering in 1979 to raise start-up capital for initial construction.

A private limited partnership — Vicon Recovery Associates (VRA) — was then formed to raise the remaining capital, with Vicon supplying $1.1 million in equity and acting as the general partner. In all, an additional $4.6 million of working capital was obtained from the private sector.

Financial projections for the Pittsfield plant call for profitable operation as of 1982. Tipping fees received from the city are based on tonnage of waste and a 15-year level fee of $11.59 specified in the service contract between VRA and the city.

The principal source of revenue to the project will be derived from the sale of steam to Crane Paper Company in Pittsfield. The sale is on a take or pay basis and is tied to the price of #6 fuel oil, which is discounted in determining the final price of the steam. Sales for 1981, the start up year, were 114 million pounds. The assumed steam sales for succeeding years will be 224 million pounds per year.

The Pittsfield experience demonstrates two things. First, that this type of Enercon controlled-air incineration technology does indeed work. In its initial year the Pittsfield plant had an online availability of 100% at its design capacity.

Second, it shows that innovative financing methods can be devised to develop resource recovery plants. Because of recent tax laws, substantial federal tax credits now exist for these types of projects, making private investment an attractive opportunity. As a result, municipalities can look to private investors for financial help in developing facilities that can solve their waste disposal problems. □

Pittsfield Incinerator Passes Tough Emissions Test

A HIGH-EFFICIENCY electrostatic granular filter proven effective in wood-fired and other solid-fuel boiler processes around the country is performing satisfactorily at one of America's largest controlled-air solid waste incineration/resource recovery plants.

The Electroscrubber® filter, developed by Combustion Power Company of Menlo Park, California, has enabled the recently-constructed, 240-ton per day plant at Pittsfield, Massachusetts to attain compliance with the state's strict emission control regulations on the first test, according to the manufacturer.

Designed, built, owned and operated by Vicon Recovery Systems, Inc., Butler, New Jersey, the 30,000-square-foot Pittsfield processing facility is situated on a five-acre site leased to the project by Crane & Co. of Dalton, Massachusetts, purchaser of steam generated by the waste incineration process — about 1.2 million pounds per day. The plant operates 24 hours a day, 5½ days a week, with 7-day operation anticipated in the near future.

Proposed as a solution to Pittsfield's solid waste disposal problem, the project was funded in September 1979 with the issuance of $6,200,000 in industrial revenue bonds by the city's Industrial Development Finance Authority. Construction began that same month and the facility began startup operation in February 1981.

The facility's three large controlled-air incinerators, designed by Enercon Systems, Inc., a Cleveland, Ohio firm specializing in solid waste incineration, energy conservation and air pollution control, are each rated at 120 tons per day. Under normal operation conditions, only two of the incinerators are on-line, with the third serving as a standby unit.

Flue gases, after exiting primary combustion chambers, are directed through secondary combustion chambers, water tube waste heat boilers, economizers, induced draft fans and finally to the dual Electroscrubber filter systems, where particulate emission is controlled to comply with Massachusetts' 0.05 gr/DSCF requirement (Figure 1).

Two Model ES-400 Electroscrubber filters share up to 90,000 actual cubic feet per minute (acfm) of particulate-laden flue gas from the two operating incinerators and are designed to reduce emission levels to a visibly clear 0.035 gr/DSCF outlet. Collected ash is conveyed pneumatically to two small, bin-vent-type bag filters, manifolded together to permit maintenance without the need for incinerator shutdown. To allow maintenance of the filter system's only moving part, the media lift-air blower, a backup lift-air blower is piped into the lines of the two operating blowers.

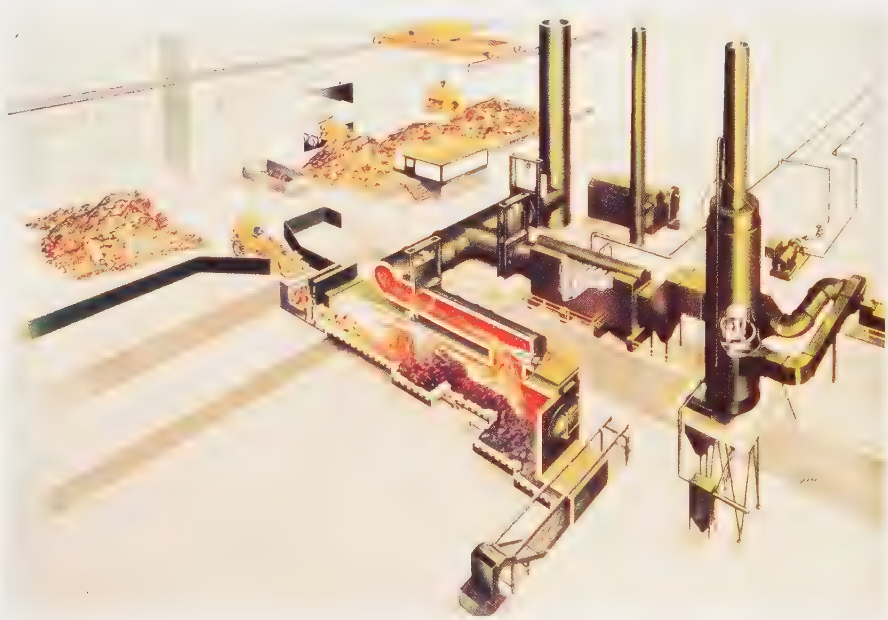
A small control panel monitors process temperature at the inlet and outlet of the filter and pressure drop across the filter, the small bag filter and the media lift pipe.

Responsibility for selection of the plant's incinerator's flue gas cleanup system was generally shared by three individuals: Vicon president Joe Domas, Dave Hoecke of Enercon Systems and Frank Reardon of Metcalf & Eddy, the Boston firm serving as engineering consultant to the city of Pittsfield. The three agree that the choice of the Electroscrubber filter derived from a number of considerations, many of which are unique to incineration of municipal waste.

"Because we would be processing fuels of irregular composition representing residential, commercial and industrial waste," Domas said, "we required a filtering system that could accept wide fluctuations in inlet loadings and temperature. In some, such as fabric filter systems we were also considering, it was virtually impossible to predict with any certainty the long-term costs associated with maintaining the filter bags. The Electroscrubber filter had demonstrated its relative insensitivity to varying inlet loadings and temperature excursions in previous applications. And the granular bed technology eliminates the risk of fire or explosion. Further, acids generated in the combustion process have the potential for causing severe problems in fabric filter, but, since the filtering media in the Electroscrubber filter is composed of small rocks, we anticipate little in the way of acid-related difficulties."

The possibility of "dewpoint caking," or plugging of the filter bags, due to water condensation containing minute ash particles, represented another area of concern, Domas said. "Preliminary tests indicated a high percentage of sub-micron particles — close to 80%. In fabric filters, caking is a real obstacle to continuous performance, and prevention frequently requires preheating the collectors with fuel other

Figure 1



than that normally burned. This involves increased costs associated with the pre-heating procedure and the non-waste fuel consumed in the process. The moving granular filter media used in the Electroscrubber filter eliminates that problem.

Availability Factor

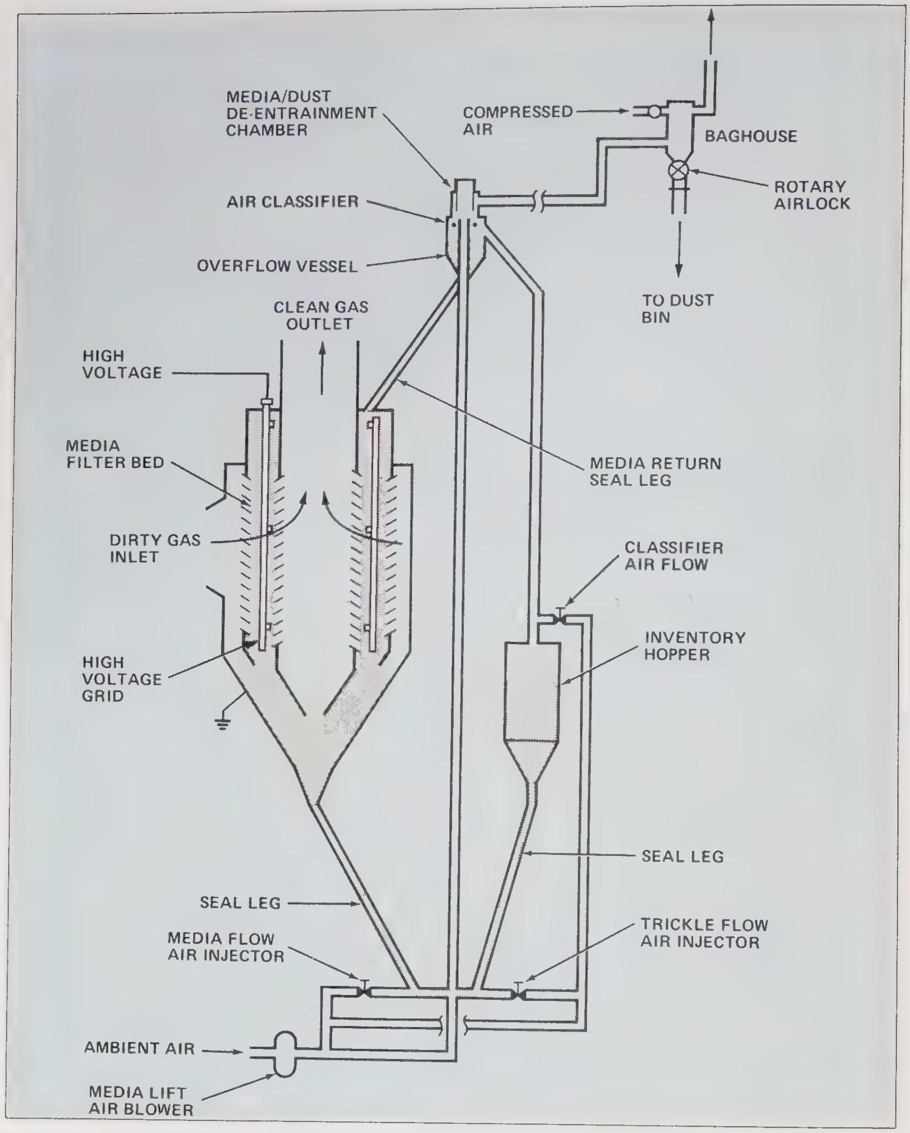
"Essentially," Domas added, "we're talking about availability. In order to fulfill energy supply commitments, we need consistent, reliable operation without having to continuously monitor the equipment. The technology of this filter doesn't require extraneous systems for operational adjustment to temperature excursions, ambient temperatures or inordinately heavy loadings which may occur. In fact, it's a very forgiving piece of equipment. Since startup, we've experienced virtually 100% availability of the entire incinerator system, and we've never failed to meet our steam delivery requirements. Although the incinerator has had load excursions from zero to 150% of rated capacity, as well as temperature excursions over 600°F into the Electroscrubber filter, the system has continued to function without any major problems."

Similarly, Hoecke considers long-term maintainability and dependable performance as essential elements leading to selection of the Electroscrubber filter. "Since the contract with Pittsfield calls for Vicon ownership and operation of the plant for 15 years, we had to approach and design the system as a user, with an eye to the long-term costs. We were in no position to experiment with systems using replaceable bags made from unproven materials for MSW applications. There was no way to accurately determine how often replacement would be necessary or how expensive that replacement might be. One fundamental feature of the chosen equipment is that the filtering media is continuously brought out of the module, cleaned and re-introduced. This allows all maintenance on the media cleanup system or on the media itself to be done while the module continues to accept gas from the incinerator, thus minimizing process downtime. Enercon recommended the Electroscrubber filter as the best answer for this MSW incineration plant from the standpoint of capital and operating cost as well as long term reliability."

Replacement Cost Critical

Reardon's firm, Metcalf & Eddy, represented Pittsfield during feasibility studies, proposal and bidder evaluation procedures and actual construction of the facility. Reardon feels the potential filter bag replacement costs for the fabric filter systems, as well as the need for over-temperature control associated with those systems, were critical factors in evaluating granular filter and fabric filter technologies. "A number of successful Electroscrubber filter applications, especially those on wood-fired boilers in the paper industry, led us to believe the system would work well on incinerators," Reardon said.

Figure 2



The combination of two relatively new technologies, the filter and the Enercon incinerator manufactured and marketed by Vicon, represents a major step toward solving the ever-increasing problems of municipal waste disposal. At Pittsfield, final ash volume is less than 10% of entering waste, and steam generated over a year's time will be the energy equivalent of 62,000 barrels of oil.

The reduction in solid waste requiring landfill disposal and the production of salable energy have been effected in total compliance with Massachusetts clean air regulations.

The Electroscrubber filter (Figure 2) essentially consists of two concentric louvered cylindrical tubes, with the annular space between them filled with pea-sized gravel media. Particulate-laden gas enters the filter through appropriate breeching and is distributed to the filter face by the plenum section formed by the vessel wall and the outer louver cylinder. Dirty gas passes through the filter media at velocities ranging from 100 to 150 feet per minute, and particulate is removed from the gas stream by impaction with the media. Clean gases then exit through a free-standing exhaust stack on top of the filter unit.

Louver Design

The filtering media is slowly and continuously moved downward in mass flow at six to ten feet per hour, resulting in a churning action across the louvers that prevents a filter cake from forming. The louver design also permits some of the media to pass through louver openings, preventing any bridging or buildup of particulate material.

Particulate-laden media is continously removed from the base of the Electroscrubber filter and pneumatically transported to the media/particulate de-entrainment section of the system. Action of the media during vertical transport in the pneumatic lift

pipe separates particulate from media so the particulate can be pneumatically removed from the de-entrainment section for further pneumatic transport to a particulate separation and storage section. Clean media then drain by gravity from the de-entrainment section for return to the top of the filter and subsequent recycling.

Applying a high voltage (50,000 volts for municipal solid waste incinerator applications) to the cage-like electrical conductor positioned within the gravel bed generates an electrical field between the conductor and the inlet and outlet louvers, enhancing collection of the fine particulate in the gas stream.

The collection capability of the Electroscrubber filter depends largely on the fact that all small particles produced in industrial processes have a slight positive or negative charge. The filter's electrical conductor, positioned within the media bed, generates an electrical field between the conductor and the inlet/outlet louvers. As particles migrate through the granular filter, they are either attracted or repelled by the charge toward one of the rocks for impaction and capture.

Because the technology utilizes the natural charge of the particles, operation is relatively insensitive to the specific electrical properties or the resistivity of the particulate. Additionally, because concentration of the particles in the media is maintained at low levels, current drain between the conductor and the louvers is minimal. □

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